The use and purpose of articles and scientists

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Nature is of an interesting size. Humans try to categorize nature by applying science so that we are able to understand and evolve. By enabling this evolution we have altered the way that knowledge is transferred between generations. From a direct transfer via observations, which is seen in the animal kingdom, to indirect transfer via e.g. the written language. In today's modern society most of the knowledge transfer occurs via indirect methods such as articles, books, and audio/visual media. This, of course, leads to a larger accumulation of information, which has its advantages and disadvantages.

The most obvious advantage is the application of the great amount of knowledge created for further advancements, i.e., creating and developing inventions. These advances can be straightforward, like the development of OLED technology for screens or they can be a byproduct of another research, as is the Post-It note, where the original research aimed for a super strong adhesive.

However, with the huge amount of information gathered it is impossible not to have partially or completely incorrect information. Thus, it is crucial to do iterative testing and have critical discussions, and to validate knowledge. Moreover, categorizing this huge amount of information is a nightmare. Organizations like IUPAC and RCSB Protein Data Bank, which categorize certain types of information, are therefore indispensable.

With the complexity of nature, the way we describe nature has to be complex and it will increase in complexity. It is like trying to fit a circular object into a box and stating that the box describes the circular object. It does so to some extent. By adding additional sides to the box, making it a pentagon, hexagon etc., we increase the precision of the description – but we also increase the complexity of the structure. This decision on the appropriate number of sides used for describing the structure is a frequent task in research. It is a difficult balance between a comprehensive description of the transferred knowledge and the efficiency of the transfer to a target audience. If knowledge is processed into a too complex description to be understood by the audience the entire rendering will be useless.

It is speculated that the time we are living in is the period with the most rapidly expanding knowledge so far, though this is not surprising given the increasing world population. Moore's law states that the number of transistors doubles every second year. This means that computation power increases steadily and – combined with modern techniques like machine learning and artificial intelligence (AI) – automatizes the collection and generation of knowledge. An organization named *Association for the Advancement of Artificial Intelligence* has even had conferences discussing future learning methods when AI gradually takes over research and day-to-day jobs. This opens up a discussion on our future and purpose when AI takes over our jobs.

All these thoughts lead to the question: Is the way we are writing articles in coherence with the way we do research today and how will future articles be written? New formats have been introduced to improve communication, such as letters, article or reviews, and additionally clarifying titles for each section and subsection in the literature. For the Journal *Nature*, the term *research article* was first used in 1933, while *letters* were introduced in the very first issue in 1869. But is the expansion of information progressing too rapid such that the presentation format of knowledge is no longer adequate?

As a greenhorn scientist, I was first truly acquainted with research articles in the second year of my bachelor studies. A half-day introductory course was given on how to read articles and search for them on *Web of Knowledge* and *Scopus*. This has been an imperative course, since it relayed key insights on how to get through an article without having to have had three cups of coffee (or five if it is a complexly written one).

At university, we are given the basic set of tools to understand different topics, as e.g. understanding what makes molecules react or how density function theory works. From here, we then explore the world using these tools, gradually improving our skill set through experience and discussions. The same prioritization should be given for reading articles, which is the bread and butter for development in science. It takes practice to read articles, and to learn how to read for which purpose. Without that introductory course my learning curve from getting the basics of an article to fully understanding the contents would have been much less steep.

Getting educated at a university causes a steep learning curve, in which multiple new skills are learned. One is structuring one's time between individual courses and the additional leisure time there may be. To my knowledge, there are very few students who achieve a graduate degree, who have read and understood every text assigned to them throughout their study program. Thus, it is a constant decision-making process, between reading a text in depth, reading it lightly or not even reading it at all, asking yourself "How important is this text for the lecture/exam?" or "Does it spark my interest?". I believe that these decisions gradually and naturally progress from the teaching material of books to the reading of an article for a project or thesis. There will always be a motivation to

read a text, whether it is for the sake of the carrot or the stick. Apart from motivation, ambition and goals also play a big role in deciding whether to surf over or drill into an article and to which degree. Nobel laureates and recognized scientists probably go far beyond the surfing through texts, and are likely to have a good sense of this decision-making and good reading skills.

It is interesting to view how the field of research has evolved from the early 1900's to modern days, where the sheer quantity of articles published might at times come at the expense of their quality. To be clear, this is not a criticism of the number of articles produced, since each research field has a certain number of articles published a year and adding correct, trustworthy information is crucial. The more reliable information, the merrier. It is criticizing poorly produced articles.

Obtaining a Ph.D. degree does not necessarily mean that one is able to communicate the knowledge one has acquired and found. Thus, it should be obvious that when acquiring a Ph.D. degree communication skills must also be acquired – as knowledge causes responsibility. The responsibility to communicate, clarify and visualize what is otherwise only visible to the few.

The purpose of science is not only to obtain new knowledge but also to make it known to the world, and to develop it further. In order to do so, science must move beyond the boundaries of narrow research groups. This means that scientists must cooperate and share knowledge via indirect communication methods. Simply because the task of the scientist is not only to discover and accumulate knowledge but to communicate it through articles that can enlighten and enrich the whole of our scientific spectrum.

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